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Lee et al.

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(54) **MASK FOR DEPOSITION AND DEPOSITION APPARATUS INCLUDING THE SAME**

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H01L 21/02 (2006.01)
C23C 14/04 (2006.01)

(52) **U.S. Cl.**
CPC ***B05C 21/005*** (2013.01); ***C23C 14/042*** (2013.01); ***H01L 21/02636*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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(57) **ABSTRACT**

A mask for deposition includes a deposition material passing portion including at least one opening column having a plurality of openings arranged in a first direction, and a frame portion adjacent the deposition material passing portion, wherein each of the openings is defined by a first slope and a second slope facing each other along the first direction and inclining toward one side of the frame portion respectively, and a third slope and a fourth slope facing each other along a second direction crossing the first direction, and wherein an inclined angle of the first slope of one of the openings at a central area of one of the opening columns is different from an inclined angle of the first slope of an other one of the openings at an outer area of the opening column.

19 Claims, 7 Drawing Sheets

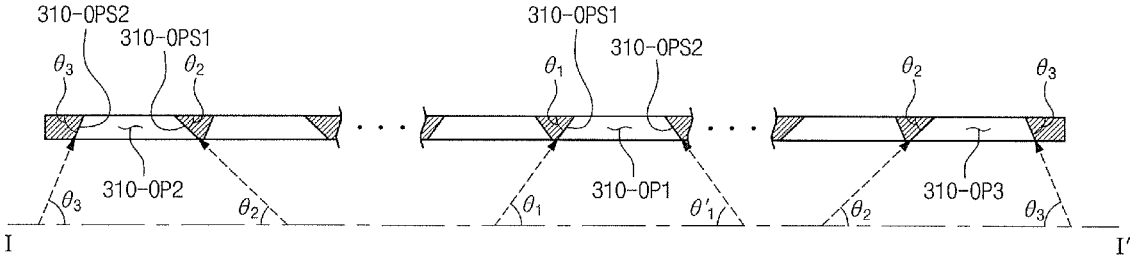


Fig. 1

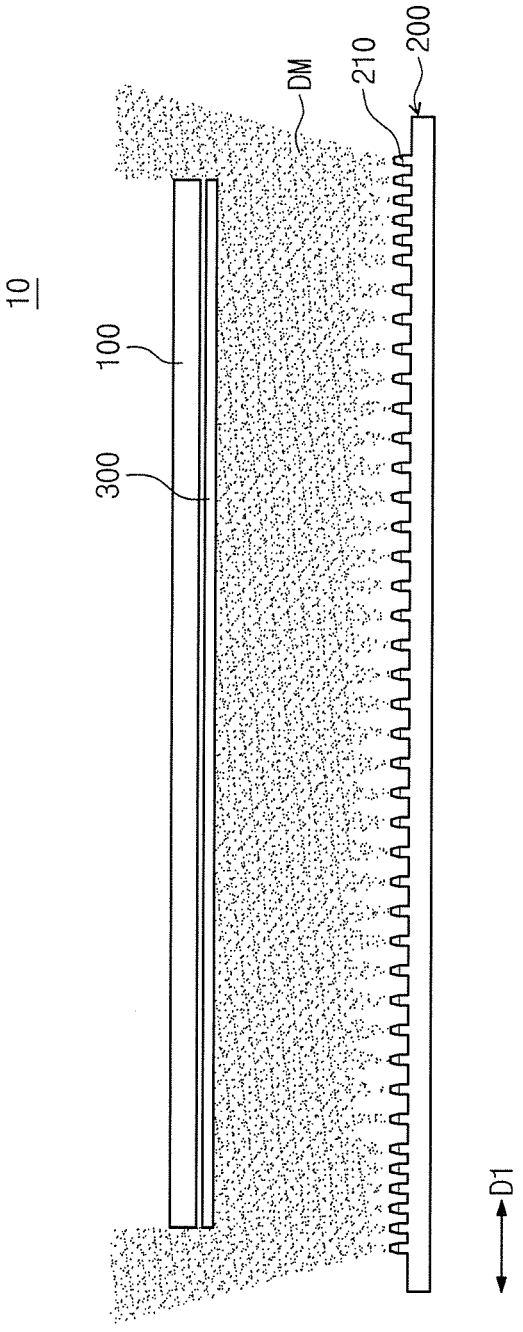


Fig. 2

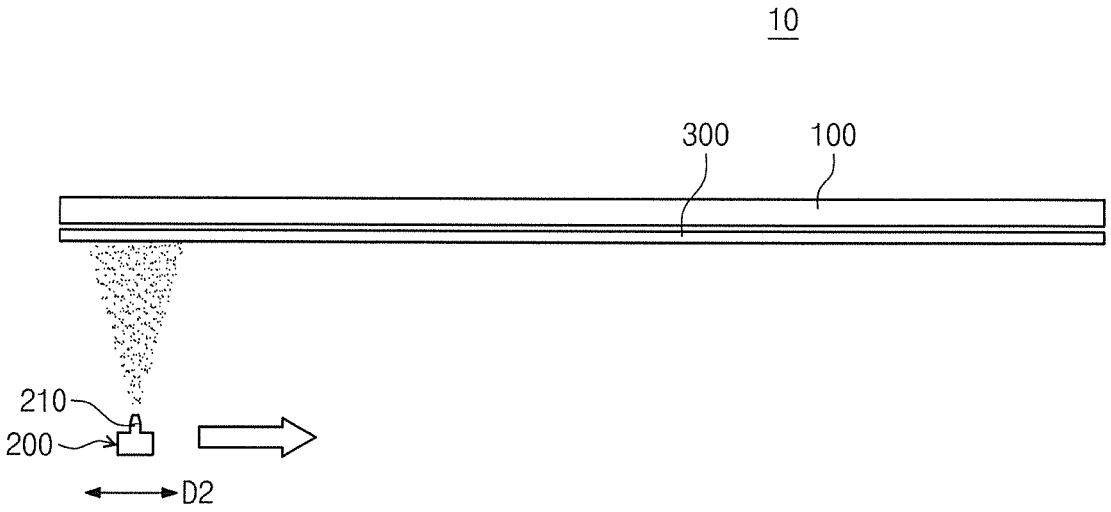
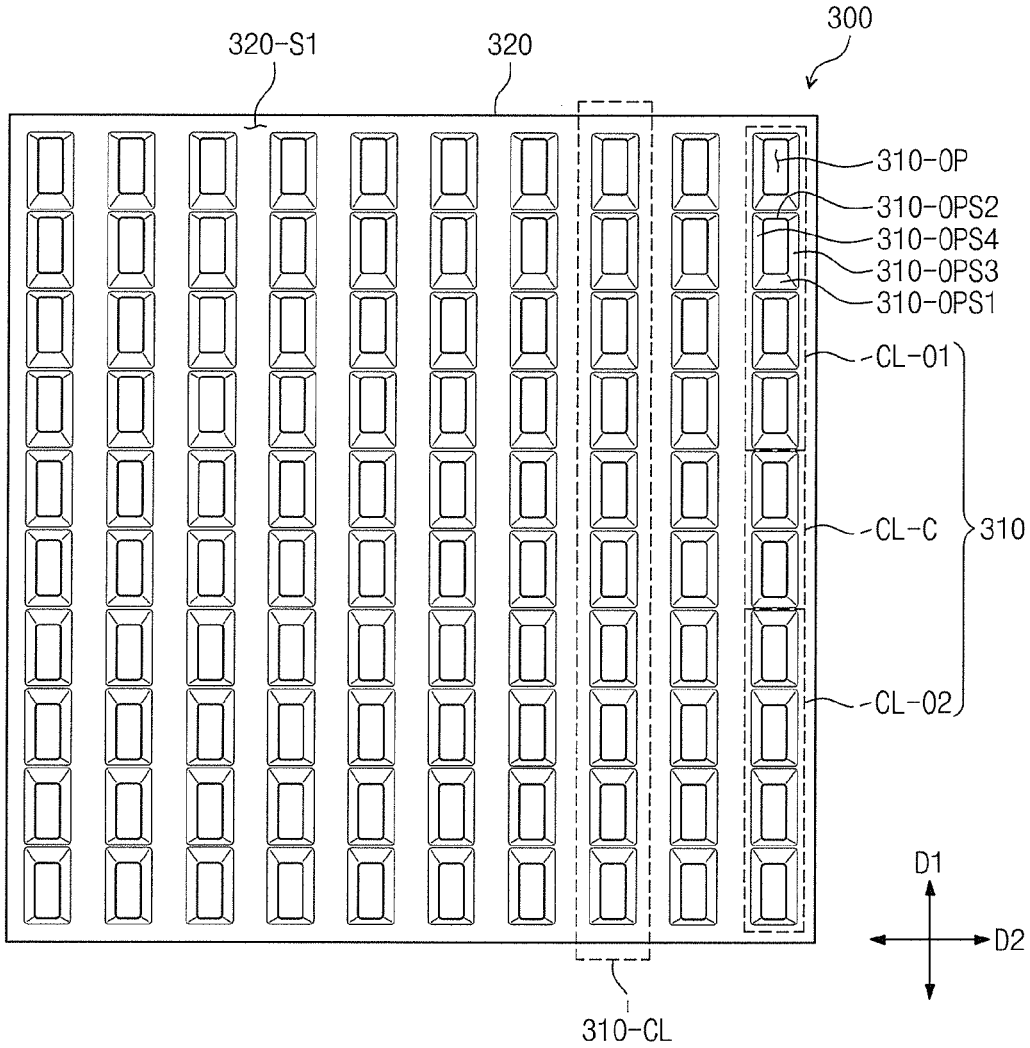


Fig. 3A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320
300
310-0P
310-0PS2
310-0PS4
310-0PS3
310-0PS1
CL-01
CL-C
310
CL-02
D1
D2
310-CL

Fig. 3B

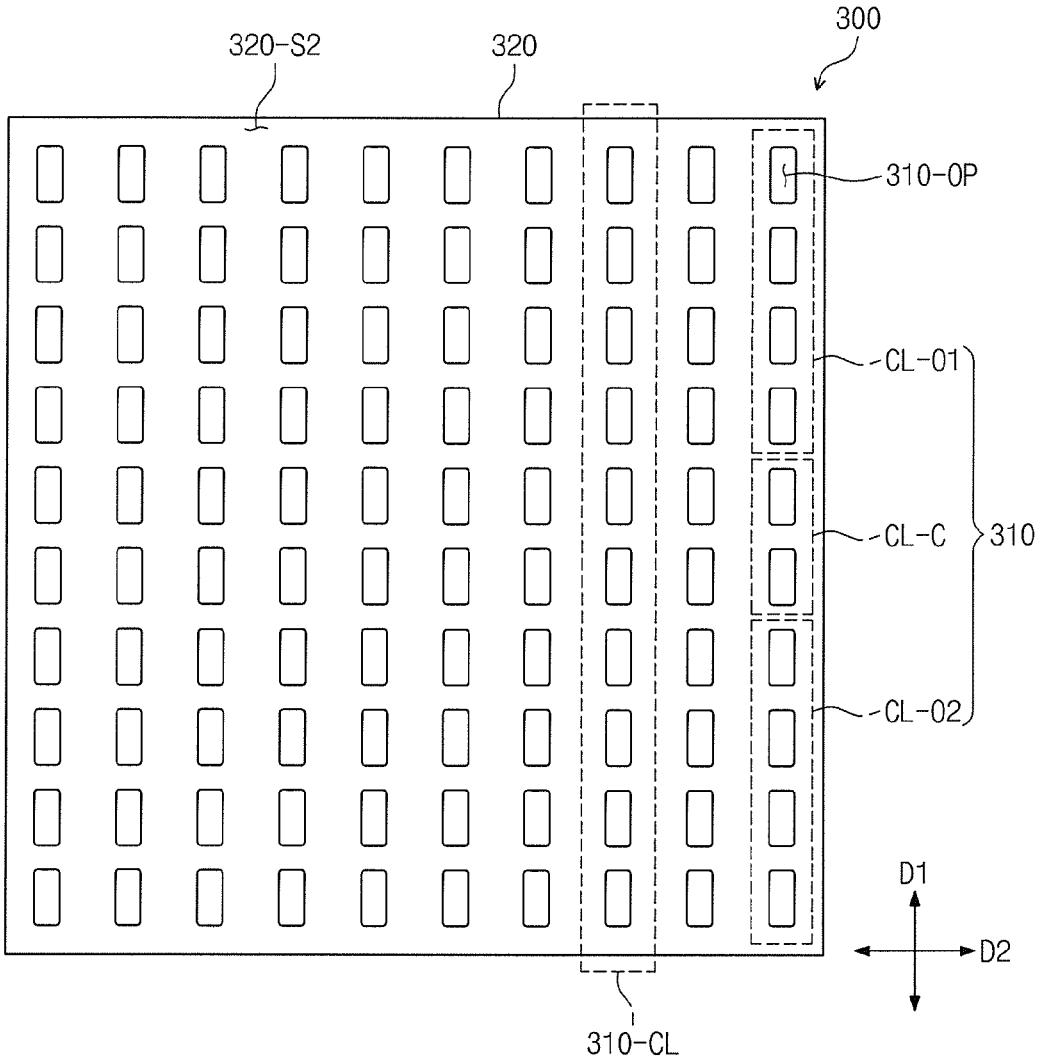


Fig. 4

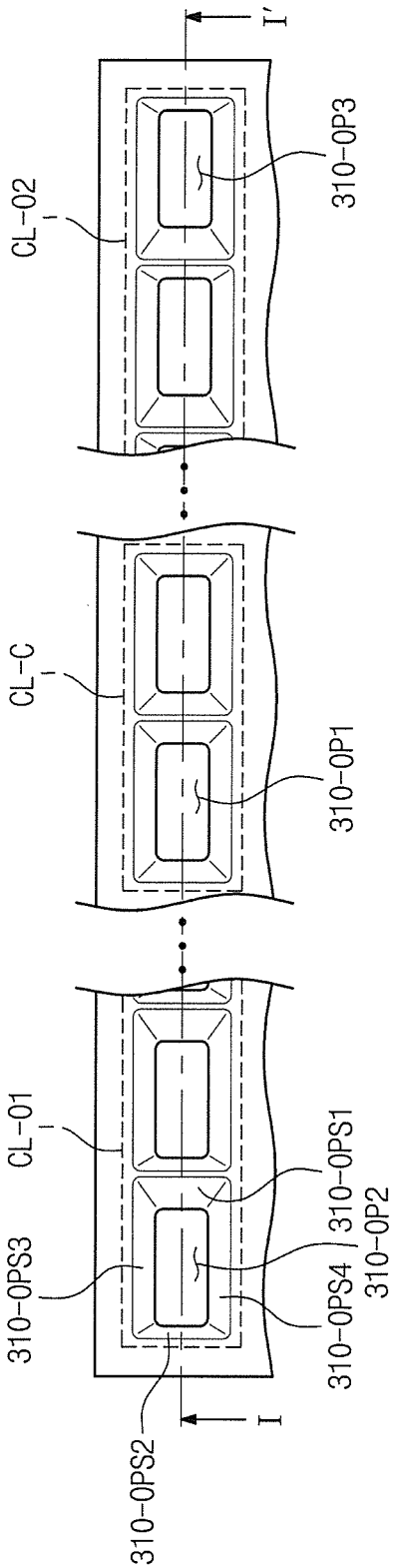

I'
CL-02
310-0P3
CL-C
310-0P1
CL-01
310-0PS1
310-0PS3
310-0P2
310-0PS4
I
310-0PS2

Fig. 5

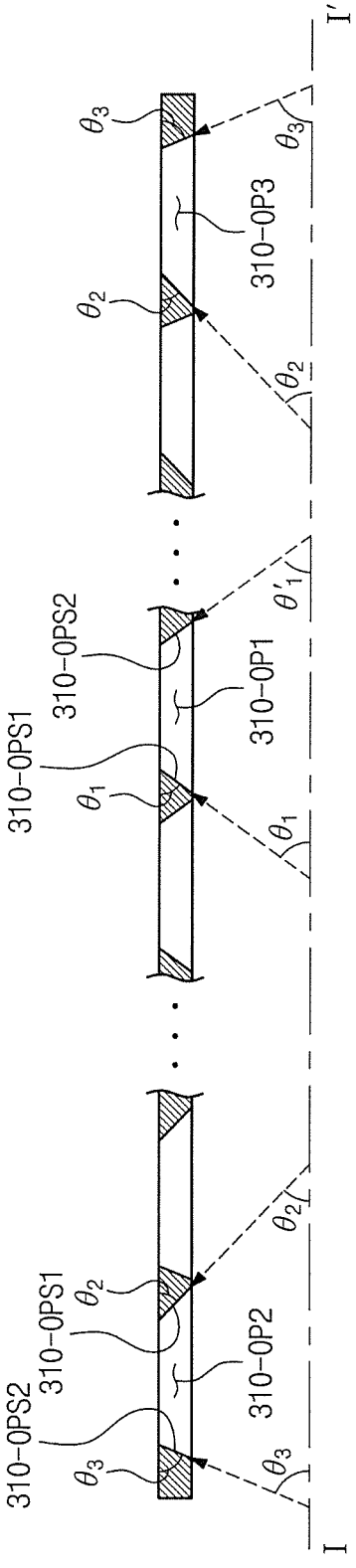

I'
θ3
θ3
310-0P3
θ2
θ2
θ'1
310-0PS2
310-0P1
310-0PS1
θ1
θ1
θ2
310-0PS1
θ2
310-0PS2
310-0P2
θ3
θ3
I

Fig. 6

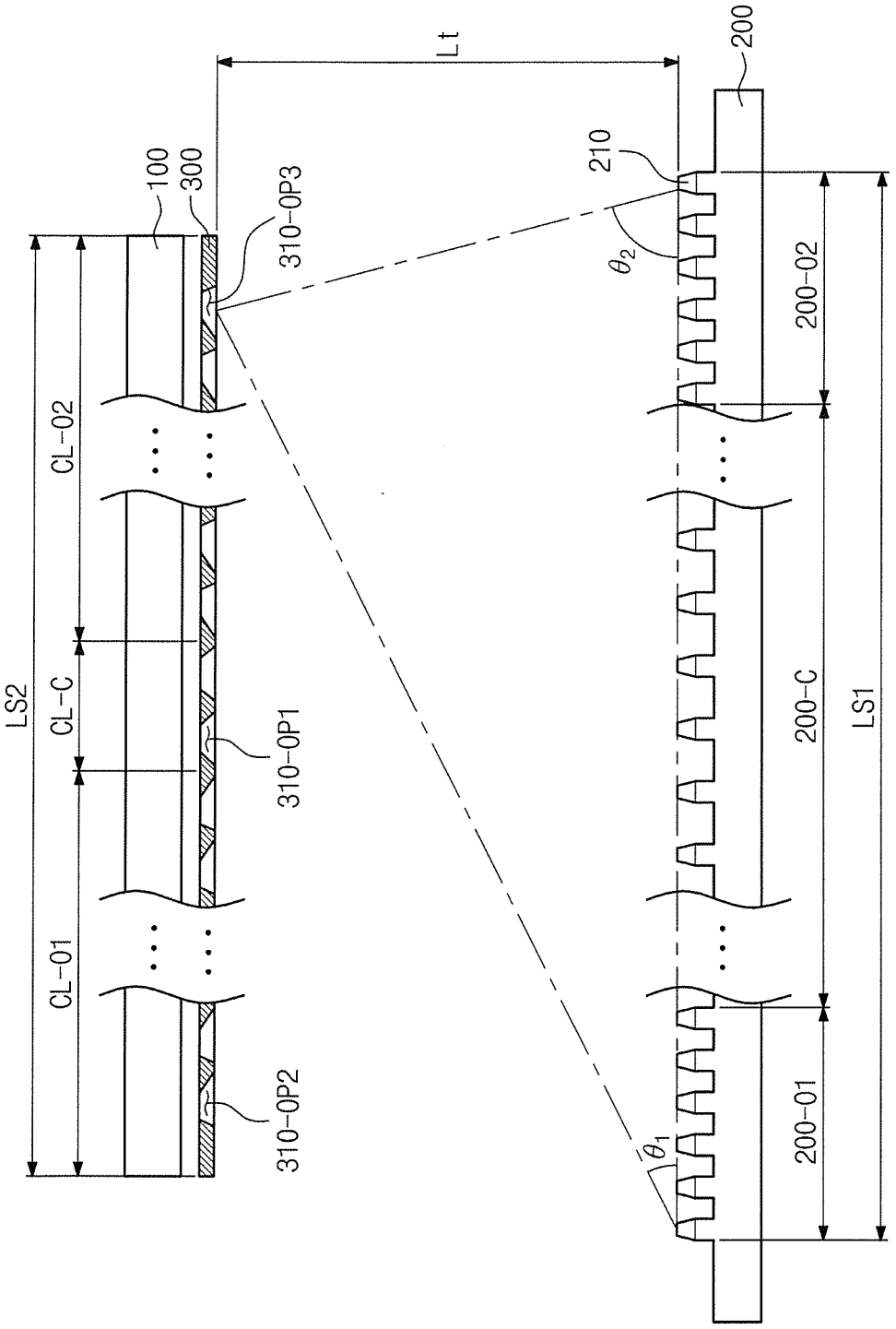
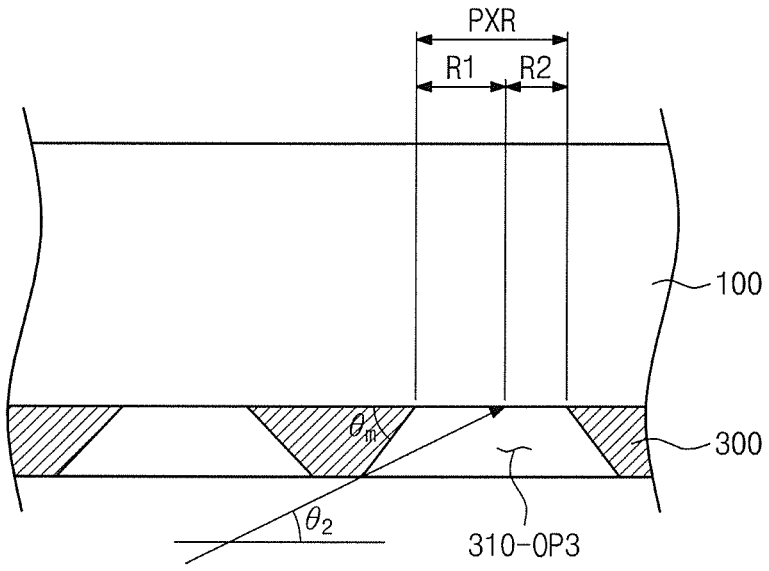

Lt
200
210
100
300
310-0P3
θ2
200-02
CL-02
LS2
CL-C
310-0P1
200-C
LS1
CL-01
θ1
310-0P2
200-01

Fig. 7



MASK FOR DEPOSITION AND DEPOSITION APPARATUS INCLUDING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to and the benefit of Korean Patent Application No. 10-2012-0006349, filed on Jan. 19, 2012, in the Korean Intellectual Property Office, the entire contents of which are hereby incorporated by reference.

BACKGROUND

1. Field

Embodiments of the present invention relate to a mask for deposition and a deposition apparatus including the same.

2. Description of Related Art

A flat panel display or a semiconductor device is manufactured by depositing various materials on a substrate. A deposition process is performed using a mask for deposition. Materials deposited on the substrate form a thin film pattern.

Recently, in response to a high integration of semiconductor devices and a high resolution of flat panel display, density of the thin film pattern is being increased.

SUMMARY

To improve performance of semiconductor devices and flat panel display, uniformity of the thin film pattern is desired.

Embodiments of the present invention include a mask for deposition. The mask may include a deposition material passing portion including at least one opening column having a plurality of openings arranged in a first direction, and a frame portion adjacent the deposition material passing portion, wherein each of the openings is defined by a first slope and a second slope facing each other along the first direction and inclining toward one side of the frame portion respectively, and a third slope and a fourth slope facing each other along a second direction crossing the first direction, and wherein an inclined angle of the first slope of one of the openings at a central area of one of the opening columns is different from an inclined angle of the first slope of an other one of the openings at an outer area of the opening column.

The outer area may include a first outer area and a second outer area, and the central area may be between the first and second outer areas.

The first slope of each of ones of the openings at the first and second outer areas may be closer to the central area than the second slope thereof.

Inclined angles of the first slopes of the ones of the openings at the first and second outer areas may be smaller than inclined angles of the second slopes of the ones of the openings at the first and second outer areas.

The inclined angles of the first slopes of the ones of the openings at the first and second outer areas that are closer to the central area may be greater than the inclined angles of the first slopes of others of the ones of the openings at the first and second outer areas that are farther from the central area.

The inclined angles of the second slopes of the ones of the openings at the first and second outer areas that are closer to the central area may be smaller than the inclined angles of the second slopes of the others of the ones of the openings at the first and second outer areas that are farther from the central area.

An inclined angle of the second slope of one of the openings at the central area may be substantially the same as an inclined angle of the first slope of the one of the openings at the central area.

The third and fourth slopes of each of the openings may incline toward one side of the frame portion.

An inclined angle of the third slope may be the same as an inclined angle of the fourth slope.

Embodiments of the present invention also provide a deposition apparatus. The deposition apparatus may include a source portion including a plurality of nozzles arranged in a first direction and configured to provide a deposition material to a substrate, and a mask for deposition between the substrate and the source portion, the mask for deposition including a deposition material passing portion including at least one opening column having a plurality of openings arranged in the first direction, and a frame portion adjacent to the deposition material passing portion, wherein the openings are defined by first and second slopes facing each other in the first direction and inclined to one side of the frame portion, and by third and fourth slopes facing each other in a second direction, and wherein an inclined angle of a first slope of at least one of the openings at a central area of the opening column is different from inclined angles of first slopes of ones of the openings in outer areas of the opening column.

A separation distance between ones of the plurality of nozzles at a central area of the source portion may be greater than a separation distance between ones of the plurality of nozzles in outer areas of the source portion.

A length of the source portion along the first direction may be greater than a width of the mask for deposition along the first direction.

The source portion may be configured to move in the second direction crossing the first direction.

The mask for deposition may be configured to be combined with one side of the substrate so that the first and second slopes face the source portion.

The outer areas may include a first outer area and a second outer area, the central area may be between the first and second outer areas, and a first slope of each of ones of the openings at the first and second outer areas may be closer to the central area than a second slope of each of the ones of the openings at the first outer area.

Inclined angles of the first slopes at the first and second outer areas may be smaller than inclined angles of the second slopes at the first and second outer areas.

One of the inclined angles of the first slopes of ones of the openings in outermost areas of each of the first and second outer areas may follow

$$\tan\theta 1 = \frac{2Lt}{Ls1 + Ls2}$$

wherein $\theta 1$ is an angle of the one of the inclined angles of the first slopes, Lt is a distance between the source portion and the mask for deposition, Ls**1** is a length of the source portion in the first direction, and Ls**2** is a width of the mask for deposition in the first direction.

One of the inclined angles of the second slopes of the ones of the openings at the outermost areas of each of the first and second outer areas may follow

$$\tan\theta 2 = \frac{2Lt}{Ls1 - Ls2}$$

wherein θ**2** is an angle of the one of the inclined angles of the second slopes.

The inclined angles of the first slopes of the ones of the openings at the first and second outer areas that are closer to the central area may be greater than the inclined angles of the first slopes of others of the ones of the openings at the first and second outer areas that are farther from the central area

The inclined angles of the second slopes of the ones of the openings at the first and second outer areas that are closer to the central area may be smaller than the inclined angles of the second slopes of the others of the ones of the openings at the first and second outer areas that are farther from the central area.

BRIEF DESCRIPTION OF THE FIGURES

Exemplary embodiments of the present invention will be described below in more detail with reference to the accompanying drawings. The embodiments of the present invention may, however, be embodied in different forms, and should not be constructed as limited to the embodiments set forth herein. Rather, the following embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the present invention to those skilled in the art. Like reference numbers refer to like elements throughout.

FIG. **1** is a side view of when viewing a deposition apparatus in accordance with an embodiment of the present invention from one side.

FIG. **2** is a side view of when viewing a deposition apparatus in accordance with an embodiment of the present invention from a different side from that shown in FIG. **1**.

FIG. **3**A is a top plan view illustrating one side of a mask of the embodiment illustrated in FIG. **1**.

FIG. **3**B is a top plan view illustrating the other side of the mask of the embodiment illustrated in FIG. **1**.

FIG. **4** is an enlarged view of a part of the mask of the embodiment FIG. **3**A.

FIG. **5** is a cross sectional view taken along the line I-I' of FIG. **4**.

FIG. **6** is a view illustrating a range in which deposition material is provided to an opening of a mask illustrated in FIG. **5**.

FIG. **7** is a view illustrating deposition material provided to any one of openings of the mask of the embodiment illustrated in FIG. **6**.

DETAILED DESCRIPTION

Embodiments of the present invention will be described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the invention are shown. Embodiments of the present invention may, however, be embodied in many different forms, and the present invention should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the present invention to those skilled in the art. In the drawings, the size and relative sizes of layers and regions may be exaggerated for clarity. Like numbers refer to like elements throughout.

FIG. **1** is a side view of a deposition apparatus in accordance with an embodiment of the present invention from one side. FIG. **2** is a side view of a deposition apparatus in accordance with the embodiment of the present invention illustrated in FIG. **1** from another side.

As illustrated in FIGS. **1** and **2**, a deposition apparatus **10** in accordance with an embodiment of the present invention includes a source portion **200** for providing deposition material DM to a substrate **100**, and a mask **300** between the substrate **100** and the source portion **200**.

The substrate **100** may be a planar member constituting a display, or may be a planar member constituting a semiconductor device. The substrate **100** may include, for example, glass, silicon, metal and plastic. Hereinafter, the substrate **100** is described as a planar member constituting a display.

The substrate **100** may include a plurality of pixel areas (not shown) and a non-pixel area (not shown) adjacent to the pixel areas. For instance, the pixel areas of an organic light-emitting display device may each include a pixel including an organic light-emitting layer. The pixel areas may be arranged in a matrix shape. The non-pixel area surrounds each of the pixel areas. The non-pixel area is an area in which a thin film transistor and a signal interconnection are formed.

The source portion **200** includes a plurality of nozzles **210** arranged in a first direction (D**1**). Each of the nozzles **210** discharges the deposition material DM. The deposition material DM may be an organic substance or an inorganic substance. The type of deposition material DM may be selected according to whether the substrate **100** constitutes a portion of display or a portion of semiconductor device. The kind of the deposition material DM may also be selected according to a step of manufacturing process. Deposition material DM deposited on the pixel area of the substrate **100** forms a thin film pattern.

The nozzles **210** may be arranged at regular intervals, or may be arranged at different intervals depending on an area. In FIGS. **1** and **2**, the source portion **200** having nozzles **210** arranged at different intervals depending on an area is illustrated.

The source portion **200** has a greater length along the first direction D**1** than a width of the mask **300** along the first direction D**1**, which will be described later. Thus, a part of the nozzles **210** may be located on the outside of the mask **300**.

The mask **300** of the present embodiment includes a deposition material passing portion (**310** of FIG. **3**A) and a frame portion (**320** of FIG. **3**A) adjacent to the deposition material passing portion **310**. The deposition material passing portion **310** includes at least one opening column (**310**-CL of FIG. **3**A). If the mask **300** includes a plurality of opening columns **310**-CL, the opening columns **310**-CL may be arranged in regular intervals.

The deposition material DM that passed through openings **310**-OP of the mask **300** is uniformly deposited on the pixel areas of the substrate **100**.

The deposition process described above may proceed in a state that the mask **300** and the substrate **100** are combined with each other. The combined mask **300** and substrate **100** may move (e.g., may move with respect to the source portion **200**) in a second direction D**2** crossing the first direction D**1**, or the source portion **200** may move (e.g., may move with respect to the mask **300** and substrate **100**) in the second direction D**2**.

In the present embodiment, the mask **300** and the substrate **100** are fixed, and the source portion **200** moves in the second direction D**2**. If the source portion **200** moves, damage of the substrate **100** that may occur due to its movement may be prevented.

The deposition apparatus **10** may further include a chamber (not shown) providing a space in which a deposition process is performed. The substrate **100**, the source portion **200** and the mask **300** may be located inside the chamber. A vacuum pump (not shown) may be connected to the chamber so that the deposition process maintains a vacuum state.

FIG. **3**A is a top plan view illustrating one side of a mask of the embodiment illustrated in FIG. **1**. FIG. **3**B is a top plan view illustrating the other side of the mask of the embodiment illustrated in FIG. **1**. FIG. **4** is an enlarged view of a part of the mask of the embodiment illustrated in FIG. **3**A. FIG. **5** is a cross sectional view taken along the line I-I' of FIG. **4**. Hereinafter, the mask **300** will be described in detail with reference to FIG. **3**A through **5**.

The frame portion **320** of the present embodiment substantially forms a frame of the mask **300**, provides one side **320**-S**1** and the other side **320**-S**2**, and surrounds each of the openings **310**-OP. FIG. **3**A illustrates one side **320**-S**1** of the frame portion **320**, and FIG. **3**B illustrates the other side **320**-S**2** of the frame portion **320**. When the mask **300** and the substrate **100** are combined with each other, the other side **320**-S**2** of the frame portion **320** is in contact with the substrate **100**.

As illustrated in FIGS. **3**A and **3**B, the opening columns **310**-CL are arranged in the second direction D**2**. Hereinafter, the present embodiment will be described with one opening column **310**-CL as the center.

The openings **310**-OP are arranged in the first direction D**1**. A separation distance between adjacent openings **310**-OP may be uniform. In FIGS. **3**A and **3**B, the opening column **310**-CL has ten openings **310**-OP.

The opening **310**-OP (e.g., the edges of the opening **310**-OP) is defined by a first slope **310**-OPS**1** and a second slope **310**-OPS**2** facing each other along the first direction D**1**, and by a third slope **310**-OPS**3** and a fourth slope **310**-OPS**4** facing each other along the second direction D**2**.

The opening column **310**-CL is categorized by a first outer area CL-O**1** and a second outer area CL-O**2** with a central area CL-C therebetween. At least one opening **310**-OP is located in the central area CL-C, and a plurality of openings **310**-OP is located in each of the first outer area CL-O**1** and the second outer area CL-O**2**, respectively.

If the opening column **310**-CL includes an odd number of openings **310**-OP, an odd number (e.g., one) of the openings **310**-OP may be located in the central area CL-C. If the openings **310**-CL include an even number of openings **310**-OP, an even number (e.g., two) of openings **310**-OP may be located in the central area CL-C. The same number of openings **310**-OP is located in the first outer area CL-O**1** and the second outer area CL-O**2**.

The first slope **310**-OPS**1** and the second slope **310**-OPS**2** incline at an angle (e.g., a predetermined angle) toward the one side **320**-S**1** and the other side **320**-S**2** of the frame portion **320**. That is, the first slope **310**-OPS**1** and the second slope **310**-OPS**2** incline from the one side **320**-S**1** to the other side **320**-S**2**.

The first slope **310**-OPS**1** of each of the openings **310**-OP located in the first outer area CL-O**1** and the second outer area CL-O**2** is arranged to be more adjacent to the central area CL-C as compared with the second slope **310**-OPS**2**. For example, in FIG. **3**A, the first slope **310**-OPS**1** of each of the openings **310**-OP in the first outer area CL-O**1** is at a bottom of the respective opening **310**-OP in a direction D**1**, while the second slope **310**-OPS**2** of each of the openings **310**-OP in the first outer area CL-O**1** is at a top of the respective opening **310**-OP in the direction D**1**. Also, the first slope **310**-OPS**1** of each of the openings **310**-OP located in the second outer area CL-O**2** is at a top of the respective opening **310**-OP in the direction D**1**, while the second slope **310**-OPS**2** of each of the openings **310**-OP in the second outer area CL-O**2** is at a bottom of the respective opening **310**-OP in the direction D**1**.

The first slope **310**-OPS**1** of the openings **310**-OP in the central area CL-C has a different inclined angle from the first slope **310**-OPS**1** of the openings **310**-OP in the first outer area CL-O**1** or the second outer area CL-O**2**. Also, the second slope **310**-OPS**2** of the openings **310**-OP in the central area CL-C has a different inclined angle from the second slope **310**-OPS**2** of the openings **310**-OP in the first outer area CL-O**1** or the second outer area CL-O**2**.

Herein, an inclined angle of the first slope **310**-OPS**1** is defined by an angle between the first slope **310**-OPS**1** and the other side **320**-S**2** of the frame portion **320**. An inclined angle of the second slope **310**-OPS**2** is defined by an angle between the second slope **310**-OPS**2** and the other side **320**-S**2** of the frame portion **320**.

The third slope **310**-OPS**3** and the fourth slope **310**-OPS**4** of the opening **310**-OP may incline toward the one side **320**-S**1** and the other side **320**-S**2** of the frame portion **320** (e.g., the third slope **310**-OPS**3** and the fourth slope **310**-OPS**4** of the opening **310**-OP may form a slope in the opening **310**-OP from the one side **320**-S**1** to the other side **320**-S**2**). At this time, an inclined angle of the third slope **310**-OPS**3** may be the same as an inclined angle of the fourth slope **310**-OPS**4**.

FIGS. **4** and **5** are enlarged views of a first opening **310**-OP**1** in the central area CL-C, a second opening **310**-OP**2** in the first outer area CL-O**1**, and a third opening **310**-OP**3** in the second outer area CL-O**2**. The second opening **310**-OP**2** and the third opening **310**-OP**3** are located on an outer side (e.g., an area farthest from the central area CL-C) of the first outer area CL-O**1** and the second area CL-O**2**, respectively.

As illustrated in FIG. **5**, the first slope **310**-OPS**1** of the first opening **310**-OP**1** has a first inclined angle θ**1**. The second slope **310**-OPS**2** of the first opening **310**-OP**1** may have the same inclined angle as that of the first slope **310**-OPS**1** of the first opening **310**-OP**1**. Since the first opening **310**-OP**1** is located in the central area CL-C of the opening column **310**-CL, the amount of deposition material DM provided to the first slope **310**-OPS**1** and the second slope **310**-OPS**2** from the nozzles **210** of the source portion **200** is substantially identical.

The first slope **310**-OPS**1** of the second opening **310**-OP**2** has a second inclined angle θ**2**, and the second slope **310**-OPS**2** of the second opening **310**-OP**2** has a third inclined angle θ**3**. The first slope **310**-OPS**1** and the second slope **310**-OPS**2** of the third opening **310**-OP**3** have the second inclined angle θ**2** and the third inclined angle θ**3**, respectively.

To deposit a uniform amount of deposition material DM on the pixel area of the substrate **100** corresponding to the openings **310**-OP, regardless of the locations of the openings **310**-OP in the opening column **310**-CL, the second inclined angle θ**2** is smaller than the first inclined angle θ**1** and the third inclined angle θ**3**.

As illustrated in FIG. **6**, the source portion **200** may be referred to as a central area **200**-C between a first outer area **200**-O**1** and a second outer area **200**-O**2**. The first outer area **200**-O**1** and the second outer area **200**-O**2** correspond to larger nozzle densities, as compared to the central area **200**-C. That is, a separation distance of the nozzles **210** corresponding to the central area **200**-C is greater than a separation distance of the nozzles **210** corresponding to the first outer area **200**-O**1** and the second outer area **200**-O**2**.

The abovementioned disparity regarding nozzles **210** is to provide a sufficient amount of deposition material DM to pixel areas of the substrate **100** located near edges of the mask

300. The first and second outer areas 200-O1 and 200-O2 of the source portion 200 don't necessarily have to respectively correspond to the first and second outer areas CL-O1 and CL-O2.

To achieve the goal described above, it is desirable that a length LS1 of the source portion 200 in the first direction D1 is greater than a width LS2 of the mask 300. The length LS1 of the source portion 200 is a distance between the nozzles 210 located on both edges of the source portion 200 (e.g., a distance between outer edges of the nozzles 210 on both edges of the source portion 200). The nozzles 210 located on the outer sides of the mask 300 sufficiently provide the deposition material DM to pixel areas of the substrate 100 located near edges of the mask 300.

A range of the first, second and third inclined angles θ1, θ2 and θ3 is described in detail with reference to FIGS. 6 and 7.

The opening 310-OP located in the outermost area of the first outer area CL-O1 (i.e., the second inclined angle θ2 of the second opening 310-OP2) follows Mathematical Formula 1 below. The second inclined angle θ2 of the third opening 310-OP3 of the second outer area CL-O2 also follows Mathematical Formula 1.

$$\tan\theta 2 = \frac{2Lt}{Ls1 + Ls2} \qquad \text{Mathematical Formula 1}$$

Lt is a distance (e.g., a vertical distance) between the source portion 200 and the mask 300, and more specifically, between an end of one of the nozzles 210 and the mask 300. Ls1 is a length of the source portion 200 (e.g., along the first direction D1), and Ls2 is a width of the mask 300 (e.g., along the first direction D1).

The third inclined angle θ3 of each of the second opening 310-OP2 and the third opening 310-OP3 follows Mathematical Formula 2.

$$\tan\theta 3 = \frac{2Lt}{Ls1 - Ls2} \qquad \text{Mathematical Formula 2}$$

The first inclined angle θ1 of the first opening 310-OP1 is greater than the second inclined angle θ2 in Mathematical Formula 1, and is smaller than 90°.

As illustrated in FIG. 7, if the third opening 310-OP3 has a second inclined angle θ2 that is smaller than the angle in accordance with Mathematical Formula 1, a part of the deposition material DM provided to the third opening 310-OP3 is deposited on only a part of the pixel region PXR. For instance, the deposition material DM discharged from the nozzle 210 located in the outermost area of the first outer area 200-O1 is deposited on a second part R2 of the pixel region PXR, but is not deposited on a first part R1 of the pixel region PXR. Thus, uniformity of the thin film pattern is reduced.

To solve the problem, the second inclined angle θ2 of the third opening 310-OP3 is determined according to Mathematical Formula 1. Mathematical Formula 1 is a formula considering an angle at which the deposition material DM discharged from the nozzle 210 located in the outermost area of the first outer area 200-O1 enters the third opening 310-OP3.

If the openings 310-OP are located not only in the third opening 310-OP3, but also in the second outer area CL-O2, and have the second inclined angle θ2 in accordance with Mathematical Formula 1, a uniform (e.g., more uniform) thin film may be formed. This is due to the fact that openings 310-OP in the second outer area CL-O2 adjacent to the central area CL-C have a larger angle at which the deposition material DM enters the openings 310-OP when compared to openings 310-OP in the second outer area CL-O2 that are not adjacent to the central area CL-C.

As illustrated in FIG. 6, even though the third inclined angle θ3 is greater than the second inclined angle θ2, the third opening 310-OP3 may uniformly receive the deposition material DM discharged from the nozzle 210 located in the outermost area of the second outer area 200-O2.

If the third inclined angle θ3 follows Mathematical Formula 2, an interval between the openings 310-OP located on the opening column 310-CL remains constant. As the second inclined angle θ2 is reduced, an area of the first slope 310-OPS1 increases. However, since an area of the third slope 310-OPS3 is reduced as the third inclined angle θ3 increases, an interval between the openings 310-OP remains constant.

Each of the openings 310-OP located in the first and second outer areas CL-O1 and CL-O2 may each have the second inclined angle θ2 in accordance with Mathematical Formula 1, or may have different second inclined angles θ2. As the openings 310-OP located in the first and second outer areas CL-O1 and CL-O2 are located nearer the central area CL-C, the second inclined angle θ2 increases. The second inclined angle θ2 is equal to or less than the first inclined angle θ1.

Each of the openings 310-OP located in the first outer area CL-O1 may have the third inclined angle θ3 in accordance with Mathematical Formula 3, or may have different third inclined angles θ3. As the openings 310-OP located in the first outer area CL-O1 and the second outer area CL-02 are located nearer the central area CL-C, the third inclined angle θ3 decreases. The third inclined angle θ3 is equal to or greater than the first inclined angle θ1.

The mask for deposition may form a uniform thin film on an area corresponding to the opening regardless of a location of the opening.

According to the deposition apparatus, openings located in an outer area of the opening column effectively receive the deposition material from the nozzles of the source portion. Thus, the openings located in the central area of the opening column and the openings located in the outer area of the opening column pass the substantially uniform amount of deposition material.

The above-disclosed subject matter is to be considered illustrative, and not restrictive, and the appended claims and their equivalents are intended to cover all such modifications, enhancements, and other embodiments, which fall within the true spirit and scope of the present invention. Thus, to the maximum extent allowed by law, the scope of the present invention is to be determined by the broadest permissible interpretation of the following claims and their equivalents, and shall not be restricted or limited by the foregoing detailed description.

What is claimed is:

1. A mask for deposition comprising:

a deposition material passing portion comprising at least one opening column having a plurality of openings arranged along a first direction; and

a frame portion adjacent the deposition material passing portion and having a first side and an opposite second side, the first side facing a source portion configured to provide a deposition material to a substrate,

wherein, each of the openings is defined by a first slope and a second slope facing each other along the first direction and inclining in a direction from the second side of the frame portion toward the first side of the frame portion,

and a third slope and a fourth slope facing each other along a second direction crossing the first direction,

wherein an inclined angle of the first slope of one of the openings at a central area of the at least one opening column is different from an inclined angle of the first slope of an other one of the openings at an outer area of the at least one opening column, and

wherein the inclined angle of the first slope is different from an inclined angle of the second slope in at least some of the openings.

2. The mask for deposition of claim **1**, wherein the outer area comprises a first outer area and a second outer area, and

wherein the central area is between the first and second outer areas.

3. The mask for deposition of claim **2**, wherein the first slope of each of the openings at the first and second outer areas is closer to the central area than the second slope thereof.

4. The mask for deposition of claim **3**, wherein the inclined angles of the first slopes of the openings at the first and second outer areas are smaller than the inclined angles of the second slopes of the openings at the first and second outer areas.

5. The mask for deposition of claim **4**, wherein the inclined angles of the first slopes of ones of the openings at the first and second outer areas that are closer to the central area are greater than the inclined angles of the first slopes of other ones of the openings at the first and second outer areas that are farther from the central area.

6. The mask for deposition of claim **5**, wherein the inclined angles of the second slopes of the ones of the openings at the first and second outer areas that are closer to the central area are smaller than the inclined angles of the second slopes of the other ones of the openings at the first and second outer areas that are farther from the central area.

7. The mask for deposition of claim **1**, wherein the inclined angle of the second slope of one of the openings at the central area is substantially the same as an inclined angle of the first slope of the one of the openings at the central area.

8. The mask for deposition of claim **1**, wherein an inclined angle of the third slope is the same as an inclined angle of the fourth slope.

9. A deposition apparatus comprising:

a source portion comprising a plurality of nozzles arranged along a first direction and configured to provide a deposition material to a substrate; and

a mask for deposition between the substrate and the source portion, the mask for deposition comprising:

a deposition material passing portion comprising at least one opening column having a plurality of openings arranged along the first direction; and

a frame portion adjacent to the deposition material passing portion, the frame portion having a first side and an opposite second side, the first side facing the source portion,

wherein each of the openings is defined by first and second slopes facing each other in the first direction and inclined in a direction from the second side of the frame portion toward the first side of the frame portion, and by third and fourth slopes facing each other in a second direction, and

wherein an inclined angle of the first slope of at least one of the openings at a central area of the at least one opening column is different from inclined angles of the first slopes of ones of the openings at outer areas of the at least one opening column, and

wherein the inclined angle of the first slope is different from an inclined angle of the second slope in at least some of the openings.

10. The deposition apparatus of claim **9**, wherein a separation distance between ones of the plurality of nozzles at a central area of the source portion is greater than a separation distance between ones of the plurality of nozzles at outer areas of the source portion.

11. The deposition apparatus of claim **10**, wherein a length of the source portion along the first direction is greater than a width of the mask for deposition along the first direction.

12. The deposition apparatus of claim **9**, wherein the source portion is configured to move in the second direction crossing the first direction.

13. The deposition apparatus of claim **9**, wherein the mask for deposition is configured to be combined with one side of the substrate so that the first and second slopes face the source portion.

14. The deposition apparatus of claim **9**, wherein the outer areas comprise a first outer area and a second outer area,

wherein the central area is between the first and second outer areas, and

wherein the first slope of each of the ones of the openings at the first and second outer areas is closer to the central area than the second slope of each of the ones of the openings at the first and second outer areas.

15. The deposition apparatus of claim **14**, wherein the inclined angles of the first slopes at the first and second outer areas are smaller than the inclined angles of the second slopes at the first and second outer areas.

16. The deposition apparatus of claim **15**, wherein one of the inclined angles of the first slopes of ones of the openings at outermost areas of each of the first and second outer areas follows

$$\tan\theta 1 = \frac{2Lt}{Ls1 + Ls2}$$

wherein:

θ**1** is an angle of the one of the inclined angles of the first slopes;

Lt is a distance between the source portion and the mask for deposition;

Ls**1** is a length of the source portion in the first direction; and

Ls**2** is a width of the mask for deposition in the first direction.

17. The deposition apparatus of claim **16**, wherein one of the inclined angles of the second slopes of the ones of the openings at the outermost areas of each of the first and second outer areas follows

$$\tan\theta 2 = \frac{2Lt}{Ls1 - Ls2}$$

wherein θ**2** is an angle of the one of the inclined angles of the second slopes.

18. The deposition apparatus of claim **15**, wherein the inclined angles of the first slopes of ones of the openings at the first and second outer areas that are closer to the central area are greater than the inclined angles of the first slopes of other ones of the openings at the first and second outer areas that are farther from the central area.

19. The deposition apparatus of claim 18, wherein the inclined angles of the second slopes of the ones of the openings at the first and second outer areas that are closer to the central area are smaller than the inclined angles of the second slopes of the other ones of the openings at the first and second outer areas that are farther from the central area.

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